Reducibility and thermal scaling in EOS multifragmentation data

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Evidence of reducibility and thermal scaling was found in the fragment distributions of the EOS Au multifragmentation data [1].

Reducibility indicates that for each bin in excitation energy, $e^* = E^*/A_0$ the fragment multiplicities, N, are distributed according to a binomial or Poissonian law. Their multiplicity distributions, P_N, can be *reduced* to a *one-fragment production probability* p, according to the binomial or Poissonian law:

$$P_N^M = \frac{M!}{M!(M-N)!} p^N (1-p)^{M-N};$$
$$P_N = e^{-\langle N \rangle} \frac{1}{N!} \langle N \rangle^N, \tag{1}$$

where M is the total number of trials.

The ratio of the variance to the mean, $\sigma_A^2 / \langle N_A \rangle$, of the multiplicity distribution for each fragment of mass A is an indicator of the nature of the distribution. The observed ratio is near one (Poissonian limit) for all e^*. See Fig. 1.

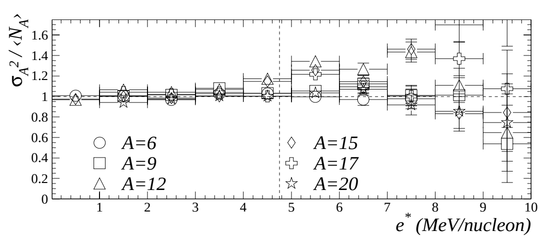

Figure 1: Ratio of the variance to the mean number of fragments of mass A versus e^*.

Thermal scaling refers to the feature that p behaves with temperature T as a Boltzmann factor: $p \propto \exp(-B/T)$. A plot of $\ln p$ vs. $1/T$ (Arrhenius plot) will be linear if p is a Boltzmann factor with B as the one-fragment production barrier.

Thermal scaling was observed when $\ln \langle n_A \rangle$ was plotted as a function of $1/\sqrt{e^*}$; T was replaced with $1/\sqrt{e^*}$ as for a Fermi gas. See Fig. 2.

Interpreting the Boltzmann factor in the terms of the Fisher Droplet Model yields a power law

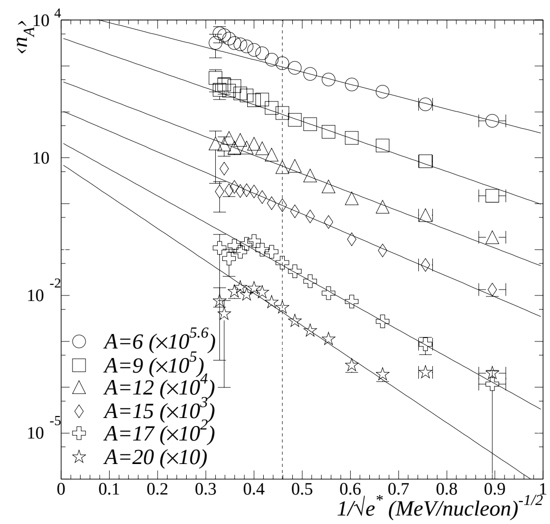

Figure 2: Normalized average fragment multiplicity versus $1/\sqrt{e^*}$ for fragments of mass A. Solid lines show Arrhenius fits.

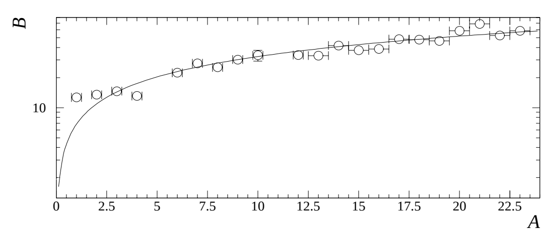

Figure 3: Power law relationship between the Arrhenius barrier, B, and the fragment mass A.

relating B to the mass of a fragment: $B = c_0 A^\sigma$ which gave an exponent equal to 0.68 ± 0.03 and an offset of $c_0 = 6.8 \pm 0.5$ MeV, an estimate of the surface energy coefficient. See Fig. 3.

References

[1] J. A. Hauger *et al.*, Phys. Rev. C **57**, 764 (1998); J. B. Elliott *et al.*, Phys. Lett. B. **418**, 35 (1998).